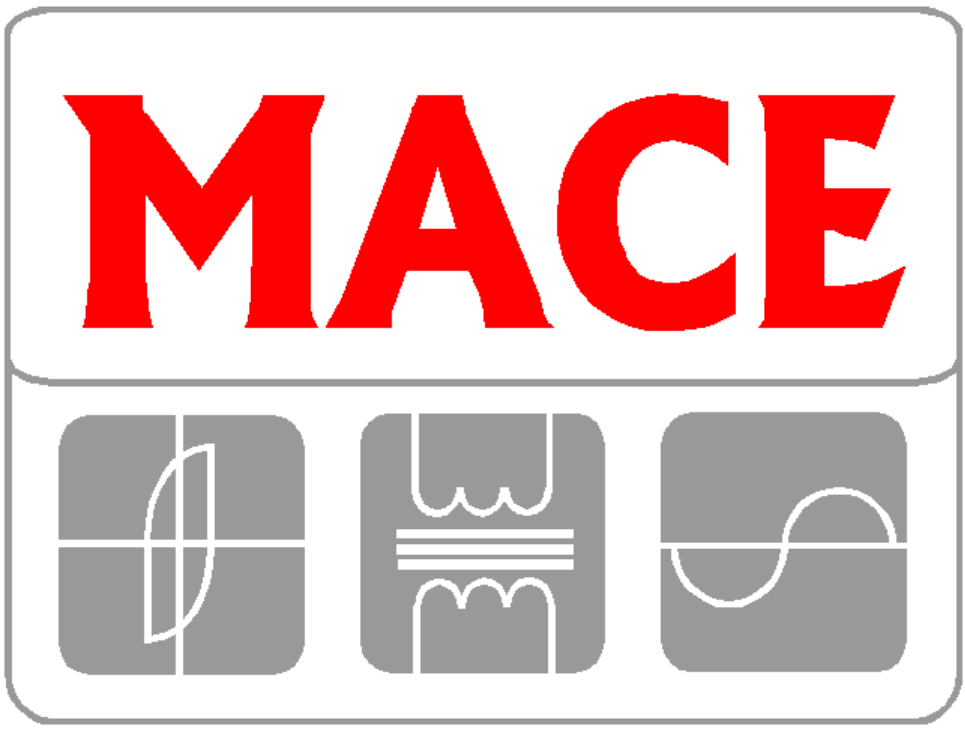

INSTRUCTION MANUAL FOR THE INSTALLATION AND MAINTENANCE OF MV/LV OIL TRANSFORMERS

1. INTRODUCTION 3

2. IEC AND CEI STANDARDS 3

3. DESCRIPTION 3

3.1 MAGNETIC CORE 4
3.2 WINDINGS 4
3.3 RADIATOR TANK 4
3.4 BUSHING INSULATORS 4
3.5 TAP CHANGER OF REGULATION 5
3.6 HV VOLTAGE SWITCH 5
3.7 OVERALL DIMENSIONS 5
3.8 BASE SUPPORTS AND SLIDES 5
3.9 PROTECTIVE COATING 5

4. ACCESSORIES 6

5. SHIPMENT, DELIVERY AND INSTALLATION 7

5.1 TRANSPORT AND DELIVERY 7
5.2 LIFTING 8
5.3 INSTALLATION 8
5.4 OTHER INSTALLATION REQUIREMENTS 9

6. PROTECTING PEOPLE AND THE ENVIRONMENT 10

7. FILLING THE TRANSFORMER AFTER LONG STORAGE PERIODS 10

8. TRANSFORMER MAINTENANCE 10

9. GUARANTEE CONDITIONS 12

10. MINERAL OIL USED FOR FILLING 13

11. QUALITY CONTROL 13

1. INTRODUCTION

This document contains a brief description and the information required for the shipment, inspection, maintenance and guaranteeing of our power and distribution transformers in oil. Each transformer must have the specific construction characteristics written on an identification plate fixed to the casing together with any technical specifications originating the supply.

The information, recommendations and descriptions contained in the document are based on experience matured by our clientele and may not take into consideration other less normal cases. Further detailed information can be supplied on request.

We would advise that this manual be read by the personnel responsible for the installation, maintenance and servicing of the transformers who must be suitable qualified and experienced.

2. IEC AND CEI STANDARDS

CEI 14 -4 (V-B3) " Trasformatori di potenza "
IEC 76-1 " Power transformers" - Part 1
IEC 76-2 " Power transformers" - Part 2
IEC 76-3 " Power transformers" - Part 3
IEC 76-4 " Power transformers" - Part 4
IEC 76-5 " Power transformers" - Part 5
UNEL tables : referred to in text
UNI tables : referred to in text IEC 551 Sound Level of transf.
UNI ISO EN 9001 Quality requirement

3. DESCRIPTION

In this section there is a brief description of mineral oil-filled distribution transformers with a natural cooling system (ONAN) and with voltage regulation on the HV side by means of a switch to be operated in no-load conditions.

3.1 Magnetic core

The magnetic core has three columns and is made of cold laminated electrical sheets with 45° oriented crystal plates. Quality and thickness of sheet : as enclosed specifications. The clamping armatures are made up of machined commercial iron sections and are designed to withstand any electro-dynamic stresses produced by fault currents, as the provisions in standards CEI 14-4 /IEC 76. Rods, nuts and bolts are made of iron and may be isolated to reduce further losses.

3.2 Windings

Windings are made of electrolytic copper conductors (UNI 5649/I – 71) or aluminium isolated with pure cellulose paper or sufficiently thick enamels.
Interlay made of pure cellulose paper of suitable dielectric properties for normal working conditions. Radial cooling channels made of glass fibre plates or dielectric pressboard, plywood or corrugated boards. Clamp supports made of evaporated beech blocks or sections.
LV winding: screw
HV windings : layered

3.3 Radiator tank

The radiator tank is made of smooth or corrugated (for sealed transformers only) steel sheet such as to avoid water collecting on the outside and gas pockets on the inside.
The radiator tank shall be fitted with base supports, slides and hoisting points as specified below. The cooling radiators are made of pressed steel sheets fitted with pipes to be connected to the tank.

3.4 Bushing insulators

The HV bushing insulators are of the type UNEL 10/250 - 20/250 - 30/250 for 10, 20 or 30 kV class respectively with a capacity load of 250 A.
The LV bushing insulators are of type UNEL 1/200 – 1/630, 1/1000, 1/2000, 1/3150 and class 1.1 kV with a capacity load of 200 to 3150 A.
The insulating material used in brown porcelain.

3.5 Tap changer of regulation

The tap changer has 5 positions that can be selected with the transformer disconnected from the electric line and is mechanically held in the position selected. The tap changer is operated manually with a selector situated on the cover in a metal ring with the markings + o – identifying the insertion or exclusion of the regulation taps.

3.6 HV voltage switch

Machines with double primary voltage can be fitted with a further switch for changing from/to high working voltage that can be selected with the transformer disconnected from the electric time and is mechanically held in the position selected.

3.7 Overall dimensions

As drawings if requested technical specifications enclosed.

3.8 Base supports and slides

Transformers are fitted with base supports and slides that conform to the specifications of table UNEL 21002-74. In particular:
- power transformers up to 100 kVA inclusive are fitted with slides
- power transformers above 100 kVA are fitted with rollers.

3.9 Protective coating

The external protective coating of the transformers and iron accessories is applied using the following painting cycle:

Surface preparation: while metal sand-blasting process corresponding to grade Sa 3 of Svenske Standards S1S 055900-12967, with the primer being applied before rust can form on treated surface.

External coating applied by dipping or spraying surfaces to be treated with epoxy paint for a film thickness of about 120 microns. Colour is dark grey (unless other wise specified) n. 7031 on scale RAL – F2.

Transformer internal surface are coated with paint resistant to hot oil (maximum temperature 100°C)

4. ACCESSORIES

Every transformer is fitted with the following standard accessories:

Oil conservator not used for sealed transformers. The oil conservator is fitted on the short side of the transformer near the LV neutral bushing insulator and is fitted with:
- oil level indicator with level marks of –20 , +20 and +85 °C
- bleed device and attachment pipe for air drier
- filler cap with safety valve.

Hoisting and anchoring devices : transformers are fitted with two lifting eyes for hoisting the whole transformer or the part that can be disconnected only. Hooks for towing or anchoring during transportation can be provided upon request.

Oil discharge devises : transformers are fitted with an oil discharge devise for gradual bleeding, this ends in a GAS UNI 5191-70 pipe fitting, normal thread and with a screw-on cap. This devise is situated on the side with the conservator.

Thermometric sump : transformers are fitted with a sump into which a thermometer can be placed to measure the temperature of the hotter layers of oil. This comprises a blind ¾ Gas pipe, 120 mm long and projecting from the cover with a treaded end.

Earth connections : transformers are fitted with two earth connections situated on the short side of the housing and made of stainless steel plates.

Electrical tests CEI 14-4 and IEC 76 classify tests on three categories :
– Acceptance tests;
– Type tests;
– Special tests;

1) Acceptance tests
a) Measurement of winding resistance
b) Measurement of transformation relationship and control of polarity and connections
c) Measurement of short circuit voltage (main tap) and load losses in relation to reference temperature
d) Measurement of no load losses and current
e) Insulation test with voltage applied at industrial frequency (50 Hz)
f) Induced voltage insulation test
g) Test on O.L.T.C. (if installed)

2) Type tests
a) Heating under rated load current
b) Insulation test with impulse voltage in normalised wave form 1.2/50 micro-sec

3) Special tests
a) Insulation tests (Part III of standards)
b) Measurement of homopolar impedance on three-phases transformers
c) Short circuit test
d) Measurement of noise level
e) Measurement of no load current harmonics
f) Measurement of the power absorbed by the ventilator motors and oil pumps

Out test laboratory is fitted out to perform the type tests and some special tests. Other special tests will have to be carried out in specialised external laboratory (independent and internationally recognised)

specifications plate this sums up all nominal characteristics of the machine as defined by standards CEI 14-4 and is fixed on the long side of the transformer.

5. SHIPMENT, DELIVERY AND INSTALLATION

5.1 Transport and delivery

The transformers in oil are normally shipped fully assembled, filled with oil and ready for installation. In order to reduce the possibility of damage occurring during transit, the transformers must be anchored by ropes tied onto the hooks provided on the transformers themselves. The ropes must be tied in a manner that does not interfere with the cooling radiators.

In all cases, when the transformer reaches its destination, it must be closely examined to check for any damage which may have occurred during transport. Any damage must be immediately reported to the carrier and our sales office informed.

5.2 Lifting

The transformer can be lifted using the special lifting hooks. The ropes must be of sufficient length to form an angle of approximately 30°.
Small lifts may be carried out using hydraulic jacks providing that suitable supports plates are provided.

5.3 Installation

The first operation to perform when installing the transformer is to assemble the wheels followed by all the checks listed below:

- Checking the oil level
All transformers equipped with an oil expansion tank have quadrant type level indicators. When installing the transformer, check that the pointer corresponds to the +20°C level.

- Checking the correct commutator position
When the transformed has been constructed to operate at two primary voltage values and is equipped with a, external commutator, check that the latter is in the mains voltage position. If the transformer has an internal voltage commutator, check that the voltage to which it is connected, normally indicated on the casing, coincides with the mains voltage.
Unless otherwise specifically requested, all our transformers are equipped with an external voltage commutator for ±5% regulation. The commutator will be in its correct position when the no-load secondary voltage is that indicated on the identification plate.

N.B. In the case where two or more transformers are connected in parallel, all the commutators must be in the same position on each unit.

- Checking the Buchholz gas type relay
If the transformer is equipped with a Buchholz relay, check that the floats are not blocked and that the relay does not contain air. If the relay does contain air, this must be bled by opening the valve located on its upper part and keeping it open until the oil with which the device is filled starts to come out.

- Checking the Buchholz shut-off valves

If the relay is fitted with one or two shut-off valves, check that they are open.

- Checking the Buchholz relay contacts
Before making any connections, manually check that the alarm and release contacts of the Buchholz relay and thermometer operate correctly.

- Air drier assembly
If the transformer is equipped with an air drier, the drier is shipped separately complete with hygroscopic salts. To assemble the drier, remove the plug from the pipe protruding from under the oil conservator, allow any oil that may have accumulated during transport to drain, remove the upper and lower plugs from the drier, wrap the pipe threads in Teflon tape or hemp thread and connect together.

- Quadrant thermometer
The quadrant thermometer, when fitted, is mounted directly on the cover and has a thermometric probe screwed into an oil filled reservoir. This provides an indication of the temperature reached by the oil in its hottest layers.
The thermometer normally has two electrical contacts, one for alarm and one for release.
For correct thermometer operation, position the alarm pointer at 90°C and the release pointer at 100°C. The use of the thermometer is particularly important when the transformer is installed in environments where temperatures may exceed 40°C.

- Earth connections
For the correct operation of the transformer, it is extremely important to earth the metal casing. This is done using the small protruding plates fitted on the lower part of the narrowest section of the casing.

5.4 Other installation requirements

In order not to compromise the cooling of the transformer, it should be installed a minimum of 30 cm from any walls and not less than 60 cm from any other transformers. The installation must also be such that allows a minimum air change of 5-6 m3/min for every KW of heat loss to dissipate.

Transformers on wheels should be anchored using wedges to prevent any movement from taking place.

Connections to the HV and lv lines must be made in line with the phase indications reported on each bushing or on the connection points in such a way that the weight of the connections does not act on them.

6. PROTECTING PEOPLE AND THE ENVIRONMENT

The impregnating mineral oil normally used is flammable, as a result of which certain precautions need to be taken.
Current "Health and Safety at Work" legislation specifies the construction of sumps or collection tanks to prevent the spread of flammable oil outside the cabin or fence lines housing electrical transformers in oil installed in non-isolated cabins and containing a quantity of oil exceeding 500 Kg.

Note that the above mentioned quantity of oil is the total amount contained in one or more machines installed in the same cabin.
The quantity of oil contained in a transformer is normally indicated in the technical catalogue or on the identification plate attached to the casing.

7. FILLING THE TRANSFORMER AFTER LONG STORAGE PERIODS

If the transformer is kept completely inactive and in storage for a long period of time, the humidity contained in the surrounding air and coming into contact with the transformer oil through the breather valve on the conservator, causes a loss in the dielectric rigidity of the insulating oil itself, thus compromising the good operation of the transformer as early as its first start-up.
In this case, the normal procedure is to check the dielectric rigidity of the oil according to the methods indicated in the "Maintenance" paragraph.

8. TRANSFORMER MAINTENANCE

Transformers do not require any particular maintenance. However, to guarantee good operation, a few periodic checks should be carried out as follows:

- Oil level check
The oil level should never fall below the level of the lid in that, if it did, there could be a discharge on the voltage commutator which could lead to the thermal dissipation capacity of the transformer to be compromise. In this case, the transformer should be suitably topped-up with dried and treated dielectric mineral oil, and any leaks identified and rectified.

- Checking the physical condition and dielectric rigidity of the oil

Yearly if the transformer is subject to overloads or works under full-load conditions, and twice yearly if the service is less severe. In all cases, the colour and dielectric rigidity of the oil should be checked.
Generally speaking, the oil initially has a light yellow colour which it retains for a relatively long time. When the colour of the oil starts to become darker, this is a symptom of the gradual ageing of the transformer. In this case, it is advisable to check the dielectric rigidity of the oil and, if considered necessary, open the transformer to check the actual state of use. The oil dielectric rigidity check consists of subjecting samples to rigidity tests according to the requirements of Standards CEI 10-1 Edition 10-87 “Standards for insulating oils for transformers and electrical equipment” from which the following paragraph has been extracted:
“At least once a Year, two samples of oil should be taken from the transformer, one from the bottom and one from the surface. The two samples are subjected to dielectric rigidity tests without being subjected to an drying or filtering operations. When the discharge voltage is equal to or greater than 40 kV, the oil can be said to be in good condition and still usable. Otherwise, it should be treated and dried.”

- Air drier check
If the transformer is equipped with an air drier, the colour of the salts contained in it, which are initially a blue colour, should be periodically checked. In time, the effects of the hygroscopic nature of the salts means that they absorb humidity from the air entering the conservator and gradually turn a red colour. At this point, the salts should be regenerated, drying them in an oven at a temperature of 120-150°C until they return to their original blue colour.

- Bushing check
The porcelain cone bushings should be cleaned periodically in that any encrustation could compromise the perfect isolation of the live terminals from earth.

- Radiator check
To ensure a good heat dissipation from the transformer, the cooling radiators should be kept clean. If the transformer is equipped with an ONAF forced air type cooling system, periodically check the operation of the electro-fans.

- Spare parts
Spare parts can be provided for all transformers supplied by us.
In the case where the parts cannot be identified with a drawing number, they must be described in as much detail as possible in addition to:
Code number and year of manufacture
Nominal power rating

Working voltages

- Request for assistance
In the case of malfunctions, our company is always available to carry out repairs on the transformer at our works. Only under exceptional circumstances and according to the size and nature of the malfunction, together with the installation conditions, can our qualified personnel be called on-site to carry out repair works.

9. GUARANTEE CONDITIONS

MACE S.a.s. guarantees all the transformers produced by it for a period specified in a contract. Unless special arrangements are made, this period is one year starting from the delivery date.

Obviously, in order to make use of the guarantee, the transformer must be installed correctly in accordance with all the following requirements.

In particular, the dielectric rigidity of the insulating oil must be accurately checked. This is carried out using the equipment as prescribed by the standards, which will determine the suitability or otherwise of the oil for guaranteeing the perfect insulation of the transformer.

The dielectric rigidity test on the oil and its eventual treatment must be carried out exclusively by qualified personnel. In this respect we are unable to give instruction but recommend our clients to contact us rather than entrust this task to unqualified and poorly equipped personnel.

The guarantee ceases to be valid in the case where the transformer is installed with a low dielectric rigidity oil or connected and protected incorrectly.

All mineral oils complying with the relevant Standards on the subject can be mixed with the oil contained in transformers produced by us.

The following are examples of damage excluded from the guarantee:
- Damage to the insulation caused by over-voltages from the mains network, those caused by atmospheric phenomena or transition activities.
- Damage to the insulation caused by overload or poor heat exchange with the environment.
- Interference without our express authorisation.
- Damage caused by the effect of poor protection co-ordination.
- Damage caused by accidental short circuiting due to, for example, loss of insulation of grounding wires or due to consumption of the external protection sheath.

10. MINERAL OIL USED FOR FILLING

Paraffin or naphthene based ecological type produced by the leading oil companies, complying with CEI Standards and free of polychlorobiphenyls PCB.

11. QUALITY CONTROL

The quality of the product is guaranteed by the application of Standards UNI EN ISO 9001 which have already been adapted to our “company quality system”.

All our transformers are regularly inspected and tested in our test room and subjected to the acceptance tests provided for by Standard CEI 14-4 “Power Transformers” or the equivalent IEC 76 Standard prior to shipment.

After this test phase, the transformers are ready to be dispatched and are delivered without wheels or air driers. These items are normally supplied separately due to transportation difficulties.